Household metabolism in European countries and cities

Kok, R.; Falkena, H.J.; Benders, R.M.J.; Moll, H.C.; Noorman, K.J.

Summary

This report is the deliverable concerning the integration of the results of Workpackage 2 (WP2) of the *ToolSust* project, *The involvement of stakeholders to develop and implement tools for sustainable households in the city of tomorrow*.
ToolSust was developed within the fifth framework programme of the EU, as a part of Energy, Environment and Sustainable Development, *Key action 4: City of Tomorrow and Cultural Heritage*, 4.1.2 Improving the quality of Urban life.

The concept of household metabolism was applied to enhance the understanding of the environmental impacts of household consumption in cities during the second phase of the ToolSust project. The household metabolism in four European cities was determined in terms of total energy requirements, including the direct and indirect energy requirement. Use was made of the Energy Analysis Program, EAP, developed at IVEM, to calculate the energy requirement of households. Energy intensities of consumer goods, calculated with country specific EAP databases, were combined with expenditure data to determine the total energy requirements of different types of households. The results are compared and the methodology is discussed in this report.

We find that the average annual energy requirement of households in different countries varies considerably, ranging from 257 GJ for the Netherlands to 327 GJ for the UK. Countries with high expenditures, Norway and the UK, also have the highest energy requirements. The share of indirect energy requirements is high in all countries, ranging from 49% for the Netherlands to 60% for Norway, and therefore needs to be taken into account by policy makers. Food, transport and recreation are important categories for all countries due to the high shares in the indirect energy requirement as well as the high energy intensities.
The total energy intensity differs between the countries. Norway has by far the lowest energy intensity with 10.7 MJ/euro, which can be explained by the low ERE value of electricity resulting from the high share of hydroelectric power. The energy intensity of the other countries ranges from 12.0 MJ/euro for the Netherlands to 13.3 MJ/euro for Sweden. The energy intensity is a result of a combination of expenditures, energy infrastructure and productions structure, and cannot, therefore, be explained easily.

The results show large variations in the annual energy requirements of average households within a country. For the Netherlands, we see that the energy requirements vary from 168 GJ in the city of Groningen to 219 GJ for the province and 257 GJ for the country as a whole. Variations are also found in the UK and Sweden. The differences between the province and the city of Groningen show that results for average households in a certain region are not directly applicable to specific cities in that region.

Several household types with different characteristics such as income, household composition, and household size were studied in the various countries. We found large variations in the annual energy requirements, which can be explained largely by the income variable. The energy requirement increases with income. The total energy intensity decreases with rising income but the indirect energy intensity increases. We see that households with higher incomes spend their money, and their energy, in a different way. The energy requirements for household effects, recreation, transport and motor fuels increase with income, while the energy requirements for natural gas

and electricity decrease. The differences found between the various income groups provide good options for change.

We found that the energy requirements increase with household size when considering the household, but decrease when calculated per person. The share of direct energy slightly decreases with household size. The indirect energy intensity increases but the total energy intensity is the same for all households. In general, income rises with increasing household size. For other characteristics also, such as the housing situation, we saw that income, or expenditure, is for a large part responsible for the differences in energy requirements. However, we did find specific features for different types of households which could be of interest when looking for options of change.

The use of the EAP tool brings about several uncertainties. Because of these uncertainties, most of the results presented in this report have a considerable margin of error. Some caution is therefore required when mutually comparing the absolute results of countries, since different assumptions have been made for each city (and country). However, the results do allow comparative conclusions within countries to be made to a fairly high level of certainty, and are therefore useful for our purposes. This is because the uncertainties mentioned above usually have the same effect (and in the same direction) for all household types. It is therefore more interesting to look at the similarities and differences between the results than to look at their individual values.
The experience showed that collecting identical types of data from various countries is very difficult. National statistical bureaus collect and present data in (slightly) different ways. The effects of using different types of data need to be studied further. We expect that in some cases the use of different statistical data might significantly influence the results of the analyses. Completing the various data sets with better quality data is a priority for further research as is further elaboration of the EAP methodology.

In this project we established that specific households have specific expenditure patterns resulting in specific energy patterns, which differ considerably from average households. It is therefore important to take into account differences in income, housing situation and household composition. Analyses of different types of households are useful for this reason, providing a basis for options for change. For instance, the emphasis for households with low incomes could be on direct energy use, namely on heating and the use of domestic appliances. Households with high incomes shift their energy requirements to indirect energy, in particular to transport and recreation and to direct energy in the form of motor fuel. Therefore, other options are available for these households. We may conclude that it is important to offer individual consumers specific advice about more energy efficient consumption patterns.